

# CalRecycle Landfill Data Summary: Part 2. Landfill Methane Emissions

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# Part 1. Landfill Data Summary- Recap

- Policy framework; Data goals, objectives, and protocols.
- CalRecycle Monthly Meeting Presentations:

April 2011- Implementation of Active Disposal Site Gas Monitoring and Control Regulations;

September 2011- focus on Landfill-Gas-to-Energy: provided 2010 waste-in-place by site, LFGTE projects, landfill footprint, total landfill gas collected, %methane, and %flared vs. recovered.

- Data compilation and presentation:

[www.calrecycle.ca.gov/ Actions/PublicNoticeDetail.aspx?id=498&aiid=483](http://www.calrecycle.ca.gov/Actions/PublicNoticeDetail.aspx?id=498&aiid=483)

# Part 2.- Landfill Methane Emissions

- Part 2 Emphasis:

Provide analysis and recommendations regarding avoided emissions from landfill methane, based on analyses of CA Waste-to-Energy (WtE) facilities and best available current information.

(Note: a detailed lifecycle assessment or analysis (LCA) was beyond the scope of this analysis. Published LCAs were reviewed and reflected in conclusions).

# What is Avoided Methane?

Methane emissions over time that would be generated if solid waste with degradable organic matter is sent to a landfill is avoided if the waste is:

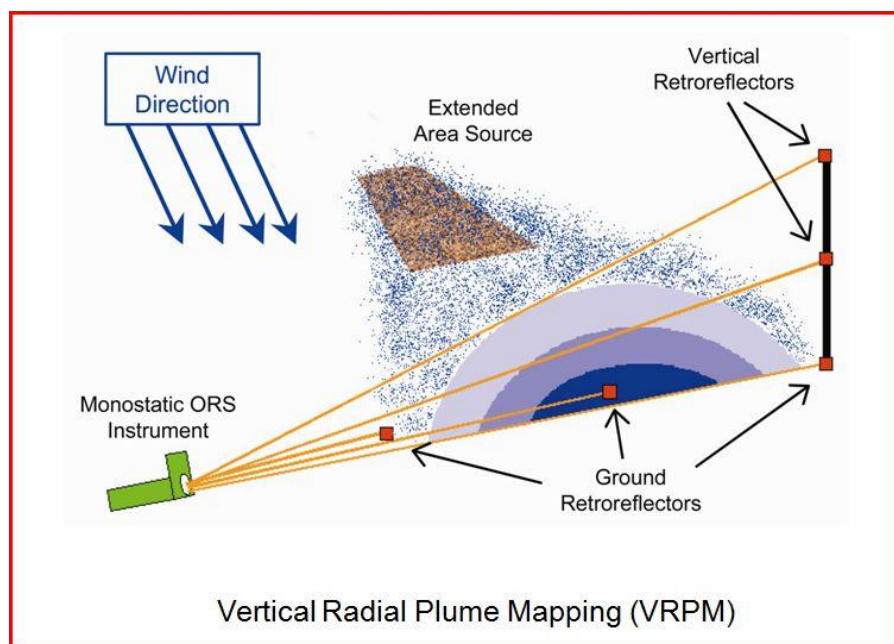
1. Diverted to composting or anaerobic digestion facilities,
2. Processed at other conversion or transformation facilities (e.g., WtE), or
3. Processed to reduce methane generation potential and landfilled.

# Estimating Methane Avoided Emissions

- First Order Decay (FOD) models- based on theoretical methane generation, default collection efficiencies and methane oxidation (e.g. IPCC and USEPA);
- CALMIM (<http://calmim.lmem.us/>)- more advanced model for CA (CEC funded project completed in 2010) that does not rely on theoretical methane generation; provides direct flux estimates based on site-specific landfill design factors; and uses field validated climate, soil, moisture, and direct measurement models.
- Limitations of FOD and CALMIM.

# Avoided LF Methane Estimates (cont.)

- Direct measurement:
  - USEPA OTM-10 method- vertical radial optical plume mapping VRPM (USEPA considers best method);
  - Tracer tests, flux chambers, surface concentration based;
  - Limitations of these methods.



# Avoided Emissions and California WtE

- Three WtE facilities are allowed partial transformation credit under the Public Resources Code (PRC). Total 800,000 tons MSW per year.
- CalRecycle staff applied FOD and CALMIM models to estimate avoided emissions for Stanislaus WtE scenario and compared with best direct measurement data.
- Based on review of WtE related comments:  
[http://www.arb.ca.gov/lists/capandtrade10/1676-2011-09\\_covanta\\_energy\\_comments\\_on\\_carb\\_cap\\_and\\_trade.pdf](http://www.arb.ca.gov/lists/capandtrade10/1676-2011-09_covanta_energy_comments_on_carb_cap_and_trade.pdf).

# CalRecycle FOD Modeling

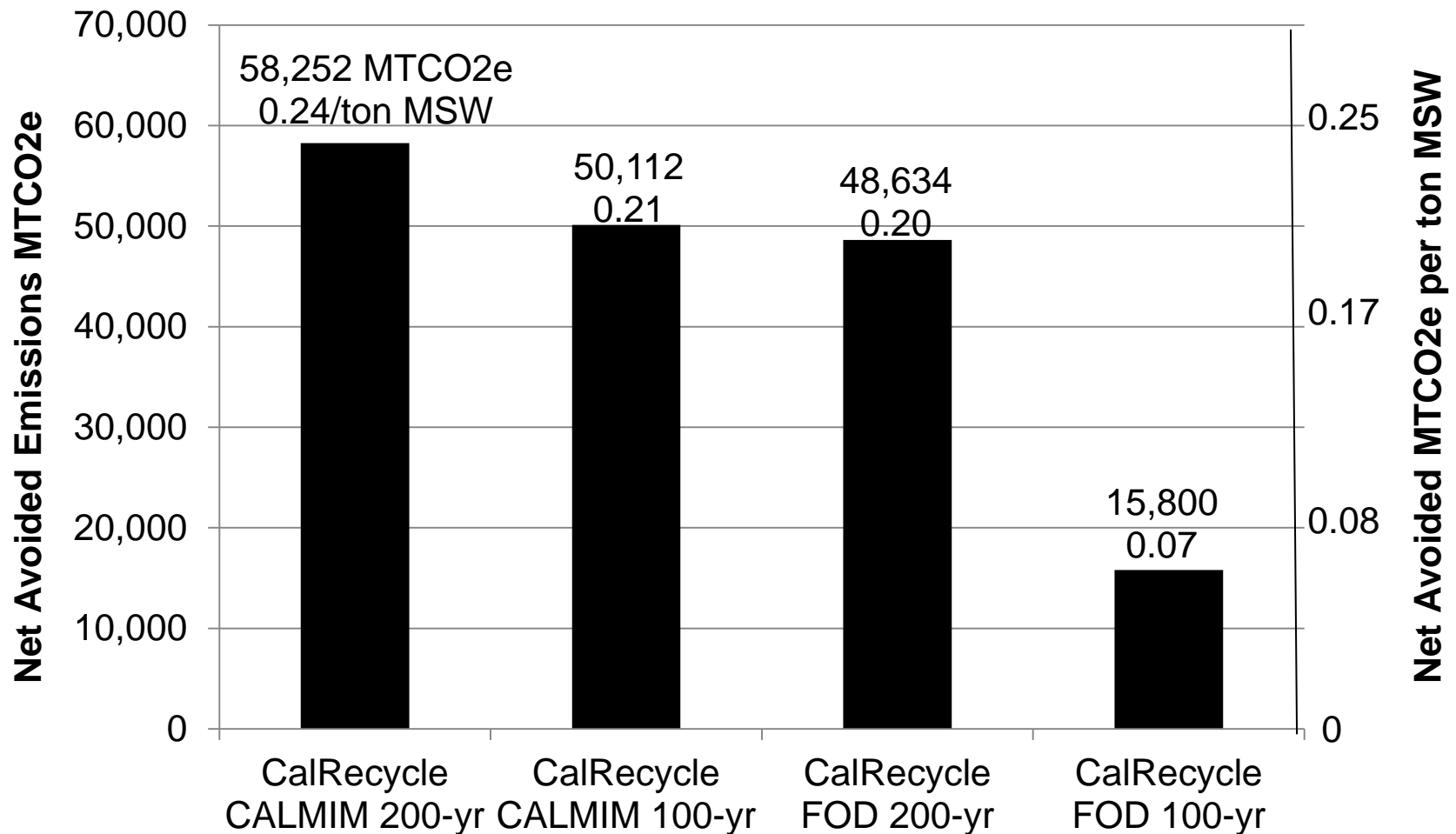
- FOD 1- USEPA default 75% collection (with control) and 10% oxidation (without control);
- FOD 2- Variable rate of collection efficiency (CE) based on Kaplan et al (2009), 0% Yrs 1-2, 50% Yr 3, 70% Yr 4, and 80% Yr 5+ until shutdown of control system, default oxidation 15% of uncollected methane;
- Landfill gas collection system shutdown year 60;
- $k$  (decay factor)=0.02 and estimated anaerobically degradable organic carbon of WtE is 8.9%.



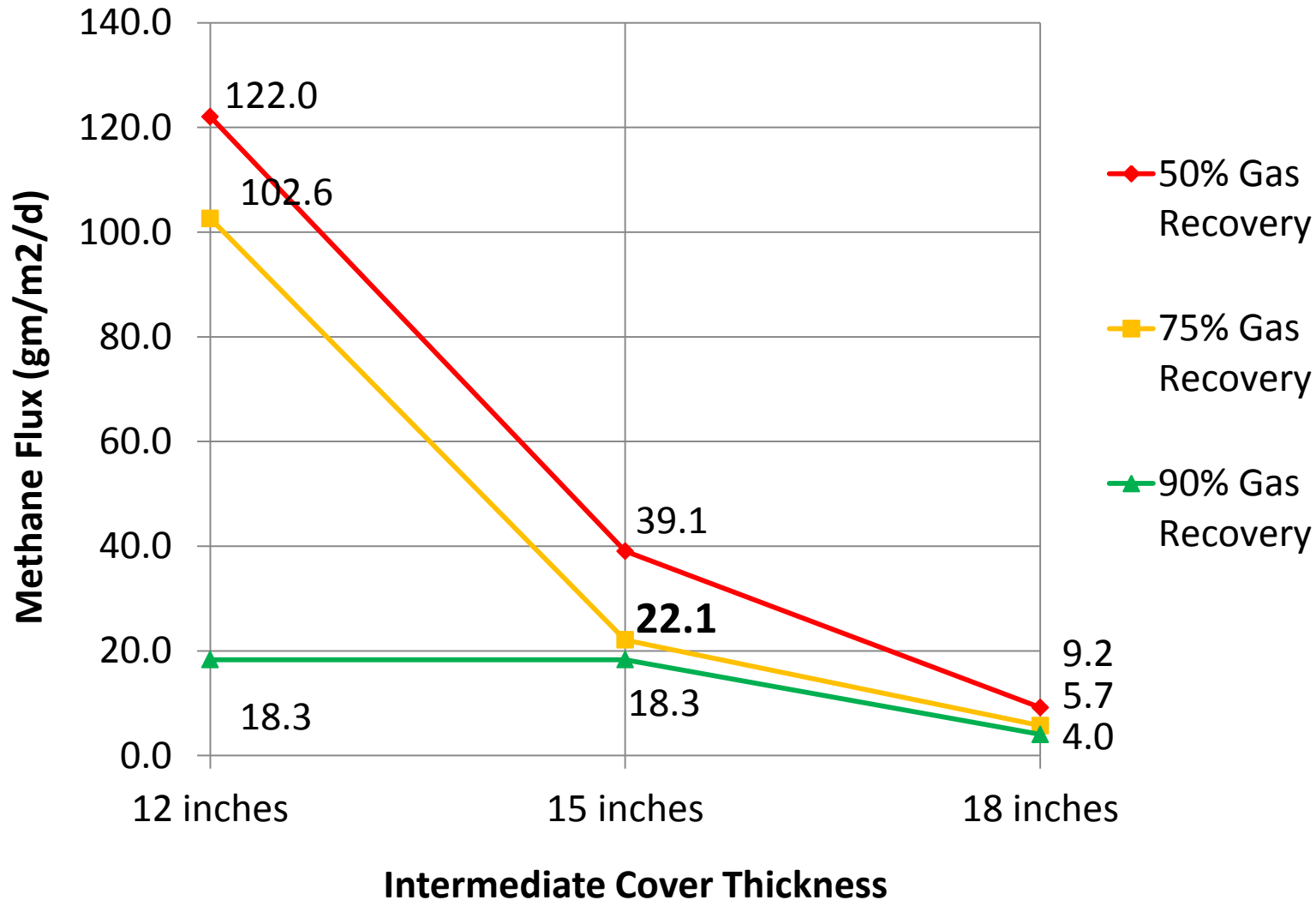
# CalRecycle CALMIM Modeling

- CALMIM V5.0C applied based on Fink Rd Landfill site. Phases: 1a- active; 1b. closure at Year 20 to shutdown at Yr. 60; 2- Yrs. 60-100; and 3. Yrs. 100-200.
- Maximum footprint 146 acres; average active footprint 90 acres, 40-yr. active life (1-yr. WtE disposal at yr. 20). Correction factor for WtE share of flux 4% (240K tons WtE/5,800K tons total)
- Silty clay loam soil; 15% area daily/85% intermediate; 75% coverage of intermediate cover by collection system; closure to shutdown site specific input and water balance final cover system.

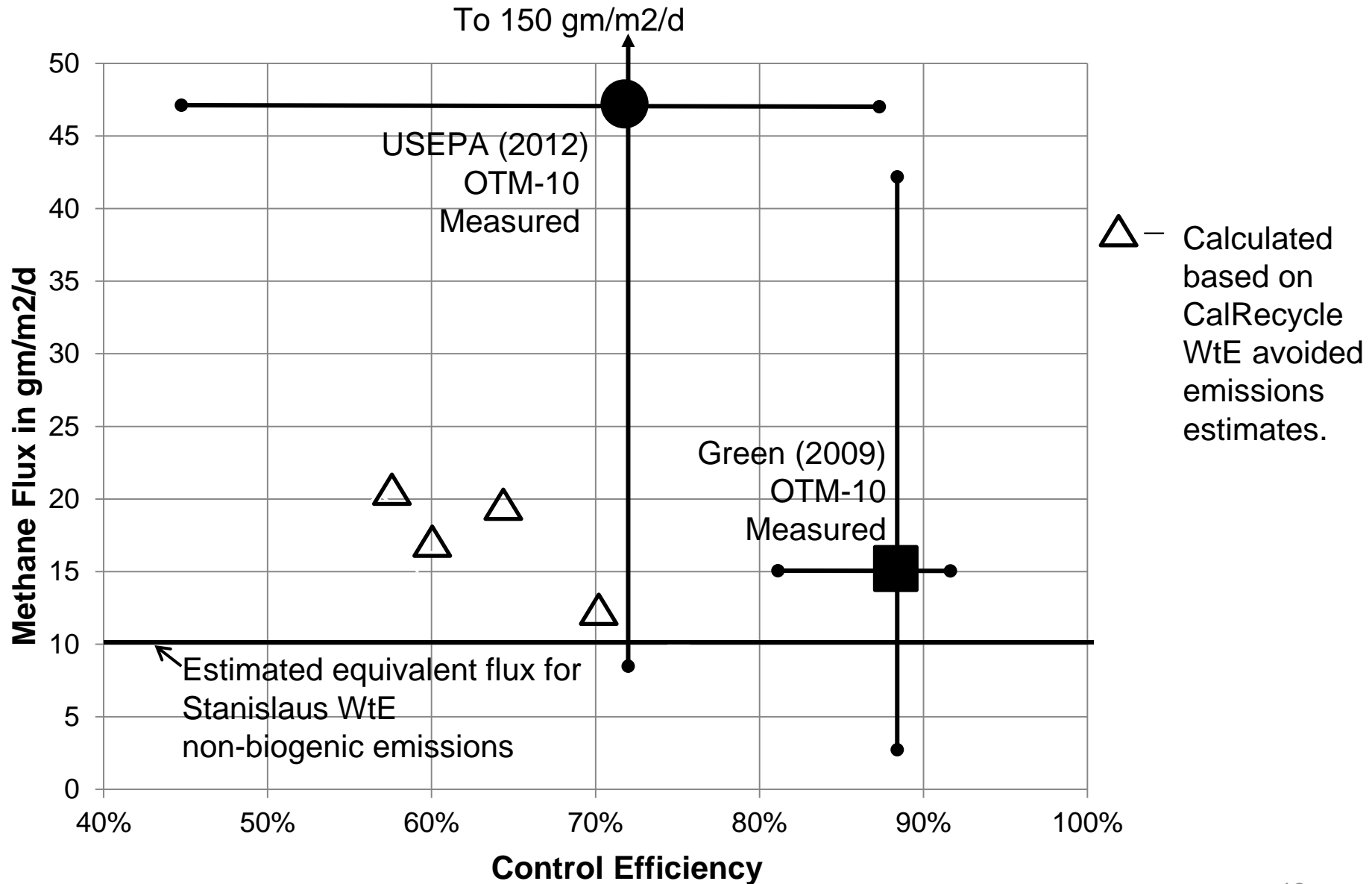
# Results: CalRecycle Estimated Net Landfill Methane Avoided Emissions for Stanislaus WtE



# CALMIM: Variation With Intermediate Cover Thickness



# Flux by Direct Measurement vs. Control Efficiency



# WtE Related Life Cycle Assessment (LCA)

- LCAs compare holistically for materials management alternatives all aspects of emissions, not just avoided landfill methane emissions;
- For WtE and landfills these other aspects include energy recovery, WtE recovery of ferrous metals and other materials, process emissions, equipment, and use of limestone in WtE emissions controls;
- Published LCA studies validate better alternative of WtE to landfills for GHG emissions.

# Conclusions

1. California WtE facilities provide net avoided GHG emissions from landfill methane that exceeds non-biogenic WtE emissions from burning of the fossil fuel based materials.
2. Conclusions would be similar for a more detailed analysis of the Commerce and Long Beach (SERRF) WtE facilities.
3. Estimated total avoided methane emissions are 0.53 MTCO<sub>2</sub>e per ton waste (0.41-0.59) and higher than ARB's prior WtE analyses. Adjusted totals based on organic content could be used to support the avoided methane emissions benefits of other materials management alternatives (e.g. composting; AD).

# Conclusions (cont.)

4. Better science with measured flux based estimates than based on control efficiency and theoretical generation.
5. These estimates are reasonably representative of landfills where an average statewide ton of waste would be disposed. Landfill avoided methane emissions may be higher or lower depending on site-specific conditions and controls.
6. The modern “dry tomb” landfill poses a potential source of additional emissions if long-term (*indefinite*) corrective action and postclosure maintenance is not assured.
7. Additional research is needed and estimates of avoided landfill methane emissions in this paper will warrant periodic reevaluation as new studies become available.

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Summary and conclusions (link to spreadsheets of data in posted Agenda Item).

Questions?

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